California Department of Transportation

Division of Research and Innovation

Annual Accomplishment Report 2008

Communication, coordination, and collaboration are the keys to a dynamic and successful research program. In keeping with this theme, the California Department of Transportation (Caltrans) is providing leadership in the development of new tools to support more effective and successful transportation research within California and in joint efforts with other states and countries.

Caltrans is working to push successful research results out to other states and countries. One of our most successful pooled-fund projects, Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS) has made the Federal Highway Administration (FHWA) Priority, Market-Ready Technologies and Innovations list that is distributed to all FHWA Division Offices. Caltrans has been working with Highways for Life to fund technology transfer of CA4PRS. This is being done by providing CA4PRS training and software licenses to other states. Currently there are two states that have purchased software licenses (with two more pending). In California, over 800 people have received training on the software. The biggest benefit of this technology is to provide “what if” scenarios that enable decision-makers to save money and time during highway reconstruction projects. In California, CA4PRS has saved over $20 million in construction costs. It has also allowed for significant time savings by allowing transportation improvements to be put into service months before conventional approaches.

Creating the Caltrans Strategic Research Plan has been a very significant effort for the Caltrans Division of Research and Innovation and Caltrans as a whole. We have developed 38 strategic research questions that tie current research to the Caltrans Strategic Plan. The Strategic Research Plan will also be a tool to make focused research project decisions that will benefit the transportation system and users of California. The Strategic Research Plan will also assist with potential coordination with other states that have similar research questions. This coordination will better utilize research dollars by producing benefits for multiple states and by leveraging critical research dollars.

Working with the five University Transportation Centers (UTC) in California to meet the transportation challenges of the future has been a rewarding and challenging experience. One such challenge is meeting the Caltrans goal of converting UTC research results into deployable products for Caltrans and other transportation agencies. One of this year's highlights was the joint California Partners for Advanced Transit and Highways-UTC conference held October 2007 in Berkeley, California where research results were shared with Caltrans and a cross-section of local transportation professionals. The response to this conference was overwhelmingly positive and led to making it an annual event.

These examples only highlight Caltrans determination to be on the cutting edge of solving current and future transportation issues through innovation and research.

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Strategic Research Selection Process

The California Department of Transportation (Caltrans) is continuing to develop and refine its research selection process to guarantee that research projects funded by Caltrans most effectively support the strategic goals, objectives, and priorities set by Caltrans management. Over the past five years, the Caltrans Division of Research and Innovation (DRI) has established a research selection process that fully involves staff technical experts throughout Caltrans to help establish the Caltrans research agenda.

As part of the research prioritization and selection process, DRI created a four-tier committee structure that involves all levels of staff and management and a full range of modal and program areas. The process is led by the Research and Deployment Steering Committee (RDSC), which is comprised of Caltrans executive leadership (Headquarters Deputy Directors and District Directors). The RDSC provides strategic direction to the selection process based on Caltrans current adopted set of five strategic goals: Safety, Mobility, Delivery, Stewardship, and Service.

Each year, following an extended review and selection cycle, the RDSC funds research that most effectively supports Caltrans adopted goals and strategic objectives. For example, in the past year, the RDSC has chosen and prioritized 38 Strategic Research Questions (SRQs) that align with the Caltrans strategic goals (Appendix). These SRQs have, in turn, been used to better focus research funding on priority research projects.

During the coming year, DRI will continue to link the SRQs with ongoing research. DRI will also identify research gaps in the current program and conduct Preliminary Investigations (PI) to begin filling such gaps with new research projects. All of this will form the basis of a Strategic Research Plan (SRP) that links Caltrans highest priority research projects to support the Caltrans strategic goals. The SRP will then become a valuable tool to guide Caltrans collaborative research efforts being conducted with state and federal agencies and research institutions throughout the country and the world.

Leveraging Resources

The DRI Office of National Liaison manages the National Cooperative Programs for Caltrans. The National Cooperative Highway Research Program (NCHRP), one of five cooperative programs, conducts research on national highway transportation issues identified by state departments of transportation (DOT). This past year, 43 of the 53 projects selected (out of 150 submitted) were rated a high priority by Caltrans staff. These 43 projects have a value of $21.5 million, of which Caltrans contribution was $3.4 million. Of the 43 projects selected that were determined to be of high value to Caltrans, DRI was able to place Caltrans staff on 22 of the project panels to ensure that California issues are addressed.

National Engagement

DRI is a key implementer of the Caltrans National Strategic Engagement Plan, which directs Caltrans to participate in national venues and forums that best support achieving Caltrans strategic goals.

DRI serves Caltrans in activities involving the Transportation Research Board (TRB) and the American Association of State Highway and Transportation Officials (AASHTO) as they pertain to research, technology, and implementation.

As the State Representative to TRB, DRI coordinates the selection and participation of Caltrans staff to each TRB Annual Meeting. Those who are chosen to participate are trained and assigned areas of responsibility. They are required to provide post-trip reports describing the recommended actions that will enable Caltrans to benefit from this participation. Participants also provide a six-month trip report describing the results of the actions. This level of involvement has resulted in Caltrans being recognized as a national leader within, and contributor to, TRB.

Listed below are a few of the highlighted outcomes from the 2008 TRB Meeting:

- Introduced federal decision-makers to Caltrans research proposal concepts. Ultimately two proposals were selected in national competition: Smart Truck Parking for $5.5 million and the *Safe and Efficient Travel through Innovation and Partnerships for the 21st Century (SafeTrip-21)* for $12 million.

- Met with federal, state, and industry bridge stakeholders to determine the feasibility of a national center for bridge preservation. The bridge preservation center planning is underway.

- Continued sharing of the Caltrans Research Program Management Database (RPMD) with other research managers. A pooled-fund project with five states was established to assist others to implement the RPMD and to enhance the features for Caltrans.

Additionally, several Caltrans employees have been invited to serve on TRB standing committees or other special national committees, and some have been invited to plan or participate on future TRB Annual Meetings or special conferences. In 2008, sixteen Caltrans staff were appointed as new members on various TRB committees based on their expertise in their respective fields and on their accomplishments.

Caltrans, the California Air Resources Board (ARB), and TRB jointly sponsored the "Data for Goods Movement Impacts on Air Quality" workshop on March 17-18, 2008, at the University of California (UC), Irvine. Approximately 20 Caltrans employees, 25 representatives from various locations in California, and 55 other representatives from other states and countries attended.

The workshop was developed to identify data sources needed to measure the impact of freight flows on air quality. At the end of the workshop, Caltrans and ARB had a broader understanding of data sources and gaps for gathering some of the data. Six main issues impacting goods movement and air quality were identified and presented to the National Cooperative Freight Research Program (NCFRP). Three of these research proposals were selected for further research as a result of this effort. Because of the positive feedback from this workshop, Caltrans, ARB, and TRB have agreed to make this an annual event. The next workshop will be held in June 2009 as a "next steps" approach. As a result of this very successful conference Caltrans is working to co-sponsor additional TRB conferences in California.

The AASHTO Standing Committee on Research (SCOR) consists of 18 members, two of which are represented by Caltrans. The Caltrans representatives were instrumental in the development of the AASHTO position on research needs for the next surface transportation authorization. They also were key members in the development of the SCOR Strategic Plan. This plan calls for leadership and action in creating a national research program that addresses current and future transportation needs through coordinated and collaborative efforts of stakeholders in all modes. It also provides direction on communicating the benefits of research to the public, elected officials and transportation officials.

This year, SCOR selected 33 new projects, one of which was submitted by Caltrans. Twenty-two Caltrans employees have been selected to participate on project panels that will guide the research, and three of the twenty-two were selected as chairs of their panels. Two Caltrans employees were nominated and selected to serve on Transit Cooperative Research Program (TCRP) panels and one person was nominated and selected to serve on a NCFRP panel. As leaders and members of these committees, these people assure that important California issues are being addressed at the national level.

Wireless Broadband at Safety Roadside Rest Areas Pilot

Caltrans has recently completed this innovative pilot project to provide travelers with timely information at the State Roadside Rest Areas (SRRA) through wireless broadband (WiFi) access. DRI initiated the pilot in 2005 to investigate the feasibility of a public/private partnership to effectively deploy WiFi access at SRRAs. Caltrans and the Great Valley Center, a regional nonprofit partner, selected two SRRAs along Route 99 for the pilot. Coach Connect Corporation (a.k.a. Road Connect), with established rest area WiFi experience in other states, participated as the private partner.

From November 2005 through July 2007, Road Connect installed and activated their standard web portal and funded the installation of WiFi services along State Route 99 at the Enoch Christoffersen SRRA in Turlock, California and Phillip S. Raine SRRA in Tipton, CA. Caltrans provided project management and engineering oversight, granted right-of-way, and funded the connectivity to the Internet.

The WiFi one-year pilot demonstration was publicly launched on July 19, 2007. Service to the public included free Internet access, as well as useful traveler information provided by Caltrans, the California Travel and Tourism Commission, and other public and private entities.

As part of the WiFi pilot, DRI contracted with the California Partners for Advanced Transit and Highways (PATH) to study WiFi implementation issues. PATH investigated different business models used by other states, conducted focus groups throughout California, and evaluated usage data collected during the pilot.

The pilot and the study were successfully completed on June 30, 2008. Caltrans and its partners demonstrated that WiFi can be deployed in California SRRAs. The pilot and the study yielded valuable data that has proven to be helpful in decision-making. For one thing, WiFi usage rates at the pilot sites were very low (less than one percent of visitors). Also, the participants in focus groups indicated that there was only lukewarm interest on the part of potential users. As a result, Caltrans determined that continued investment of public money for implementation at the remaining SRRAs was not warranted.

Based on the pilot experience and PATH's study of business models, it was evident that California would face significant challenges if it were to initiate a public/private partnership at no cost to Caltrans. Although several tried, no state was able to sustain a business model with all costs incurred by the vendor. Also, this pilot began with Road Connect assuming most of the costs, but they were unable to finish the pilot without additional funding from Caltrans. Additionally, only one respondent to the DRI February 2008 Request for Information on this project suggested a no-cost solution for Caltrans, and this vendor had no experience with WiFi. California faced roadblocks in structuring a contract that would satisfy the many legal and contractual issues that became evident with a no-cost-to-Caltrans effort.

Even though California elected not to continue with its plan to install WiFi at the SRRAs, the pilot and the PATH study were necessary elements in helping Caltrans make an informed decision.

Balsi Beam

Recognizing the trends in work zone injuries and traffic congestion, there is a need to improve work crew, public safety, and traffic mobility issues related to shoulder and median work performed on California’s roadways. The DRI teamed with the Division of Maintenance, the Division of Equipment, Legal Division and Division of Procurement and Contracts to commercialize a prototype of a lateral Mobile Work Zone Protection System known as the Balsi Beam.

The Balsi Beam is a truck-mounted, expandable beam that will provide work zone protection for Caltrans workers performing shoulder work on the highway. The potential for the Balsi Beam to improve safety among highway work zones would add positive

protection against highway occupational injuries and fatalities and helps Caltrans to achieve the goal of zero deaths of highway workers in work zones.

The Balsi Beam has gained world recognition since its initial development. Other state departments of transportation (DOTs), as well as international transportation organizations, have expressed interest in acquiring the device. The North Texas Tollway Authority has been successful in executing a license agreement with Caltrans for the use of the Balsi Beam. This interest from other transportation agencies speaks to the importance of providing lateral impact protection for short-term work zones.

A Request for Proposal (RFP) is being developed to allow Caltrans to commercialize the Balsi Beam to allow external agencies to procure the Balsi Beam for their use. Caltrans primary goal is to increase the availability of the Balsi Beam in the work zones across the nation. This includes the capability to market, manufacture, and distribute it nationally, and the capability to provide training and support.

The Balsi Beam was accepted by the AASHTO Technology Implementation Group (TIG), which facilitates the implementation of high-payoff, ready-to-use, innovative technologies. Caltrans owns and maintains the only Balsi Beam to date. Also, Caltrans holds the patent to the Balsi Beam and hopes to procure additional Balsi Beams in Fiscal Year (FY) 2008/09.

The Balsi Beam embarked on a national showcase in cooperation with the FHWA Resource Center to demonstrate the device across the nation. The device has received overwhelmingly positive reviews for its user-friendliness, ease of operation, and potential to save lives.

The prototype is currently being used in Caltrans District 3-Marysville with a Bridge Maintenance Crew. Using the Balsi Beam has improved the crew's safety and morale, as well as their production rate. It takes approximately 20 minutes to deploy the Balsi Beam and in some cases eliminates the need for a lane closure. This saves the traveling public time and traffic congestion.

Caltrans hopes to see additional Balsi Beams deployed in the future for the hard working employees who maintain our highways and bridges and create a safe transportation system for everyone.

Bus Rapid Transit Research

With fewer opportunities to increase highway capacity statewide, new approaches to transport the maximum number of people are needed to meet the future travel needs of a growing California population. To assure the greatest utilization of our existing highway facilities, Caltrans Director Will Kempton issued a new Caltrans policy in February of 2007 to support implementation of Bus Rapid Transit (BRT) strategies on the State Highway System. Caltrans is working closely with transit operators, local

jurisdictions, and planning agencies to plan, develop, implement, and advocate BRT systems.

BRT employs modern vehicles that are fast, frequent, and competitive with the private automobile. Special bus lanes take these high-occupancy vehicles out of the congested mixed traffic, enabling them to travel faster and reduce delay at signalized intersections. Sheltered stations have more passenger amenities and are spaced further apart to allow faster bus speeds. Service is more reliable and low-floor vehicles are convenient to board. Today, BRT is emerging as a cost-effective, high-capacity transit service that has many of the same features as light rail transit – features that people like. Improved travel times and increased frequencies are attracting more riders to transit, and new BRT services carry many former single-occupant vehicle drivers (comprising nearly 20 percent of BRT patronage).

To assist in the successful introduction of fast, frequent, and high capacity BRT service, DRI engaged an expert team of former Caltrans executives and a major California transit system general manager to develop *"A Handbook for Partners."* In cooperation with the Mineta Transportation Institute, a statewide BRT task team was formed under the leadership of the Caltrans Division of Mass Transportation. Members of the team included representatives of major transit systems in California, planners and engineers from Caltrans headquarters and districts, and stakeholders from the transportation community.

Transit users want frequent, reliable service in an environment of personal safety. Physical improvements, while contributing to user satisfaction, only indirectly meet traveler needs. The results of this research are helping transit operators construct and maintain cost-effective stations that best satisfy the needs of transit riders.

Research has continued to bring several new technologies closer to deployment. Caltrans and field partner San Mateo County Transit District (SamTrans) have been leaders in developing an Adaptive Transit Signal Priority (ATSP) system. The test results have shown that ATSP yields more travel-time savings for buses and less impact to cross traffic. Further Transit Signal Priority improvements will consolidate the growing collection of electronic devices on each bus and introduce Dynamic Passenger Information features. These products will have application nationally and will improve corridor-wide mobility, reducing travel times and delay.

To help BRT buses negotiate narrow lanes (ten feet wide), operate on one-way roadways, and dock precisely at stations, automated bus guidance has been under development and DRI recently completed a field operation test on State Highway 185 in San Leandro. This successful test was conducted in mixed traffic on a proposed BRT route of Alameda-Contra Costa Transit District (AC Transit). Automated bus guidance will permit the use of narrower bus lanes that result in reduced right-of-way costs and increased travel safety. High speeds and limited stop features, similar to light rail transit, characterize BRT. This lane-assist technology, using permanent magnets imbedded in the roadway, enables BRT vehicles to rapidly approach low platform stations and maintain a narrow-gap spacing between the bus and the platform.

As the new BRT policy is being implemented in the field, the traditional paradigm of giving all capacity increases to mixed-flow vehicles is being re-examined through research in light of the desire to enhance capacity and move more people, not just their vehicles (which are typically 80 percent empty). Bus lanes on conventional highways, bus ramps, and high-occupancy vehicle lanes on freeways are all elements of the new BRT concept and a central theme in Caltrans public transit policy.

Efficient Deployment of Advanced Public Transportation Systems

The Efficient Deployment of Advanced Public Transportation Systems (EDAPTS) concept is based on the premise that technology be simple and affordable. This research project focuses on making Intelligent Transportation Systems (ITS) solutions accessible to small rural and urban transit agencies. The primary objectives of the research are to lower the life-cycle cost of transit ITS technology and to eliminate the deployment barriers created by proprietary products and information.

A test deployment is underway at California State Polytechnic University, Pomona, on the Bronco Express campus bus service. This test uses unique performance specifications developed with the EDAPTS approach to determine feasibility to procure commercial products that are consistent with the low-cost, expansible objectives of the project. The objective is to develop private-side suppliers who will provide products for small transit agencies that utilize the EDAPTS approach.

Caltrans has retained the California Center for Innovative Transportation (CCIT) to help move the current EDAPTS research into practice statewide. CCIT is surveying the market of small transit providers to determine core needs and interest in ITS. CCIT is also searching the marketplace for potential commercial suppliers. Once suppliers for EDAPTS-compliant hardware and software have been found, partnering opportunities will be sought for the final research activity – a full-scale deployment of an EDAPTS small transit procurement in California.

Construction Analysis for Pavement Rehabilitation Strategy

Most state highways in the United States were built during the 1960s and 1970s and have exceeded their design lives. With mature and aging infrastructures, transportation agencies have shifted their focus from constructing new highways to rehabilitating existing facilities. Because highway rehabilitation projects often cause congestion, safety concerns, and limited access for road users, agencies face a challenge in finding economical ways to renew deteriorating roadways in metropolitan areas.

Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS*)* is achieving national level innovation status. CA4PRS is a schedule, traffic, and cost analysis tool that helps planners and designers select effective, economical rehabilitation strategies. This project has been funded through a FHWA pooled-fund. Contributing states are California, Minnesota, Texas, and Washington. CA4PRS was developed by the

University of California Pavement Research Center (UCPRC) through the UC Berkeley Institute of Transportation Studies.

Since 1999, the capabilities of *CA4PRS* have been validated on major highway rehabilitation projects in California, Washington, and Minnesota, including the I-10 Pomona, I-710 Long Beach, and I-15 Devore Projects, the I-5 Seattle Project, and I-494 St. Paul Project, respectively. Recently, more Caltrans design and traffic engineers are using CA4PRS to develop construction staging plans and transportation management plans (TMP) for their upcoming major highway rehabilitation projects (including the I-15 Ontario concrete project, the I-680 Walnut Creek precast project, the I-280 Santa Clara project, and the US-101 asphalt concrete project).

FHWA formally endorsed *CA4PRS* as a "Priority, Market-Ready Technologies and Innovations" product in 2008. FHWA is also supporting a *CA4PRS* group license from UC Berkeley to distribute to all 50 states through the State Pavement Technology Consortium pooled-fund (including a brief introductory training) for nationwide deployment. The AASHTO Technology Implementation Group (TIG) is focusing on *CA4PRS* for nationwide promotion to its state members, and is in the process of establishing a campaign to market the software in the *AASHTOWare* product line. In October 2007, the project team in Caltrans and UCPRC for the development and implementation of CA4PRS received the Global Road Achievement Award in Research area from the International Roads Federation. In March 2008, Caltrans Director Will Kempton acknowledged this achievement and encouraged practice and deployment of CA4PRS software within Caltrans.

CA4PRS has been introduced by DRI and the developers to more than 30 state DOTs through videoconferences (March and September 2007) and web-seminar (January 2008). Throughout the U.S., there is growing recognition of the capabilities and benefits of CA4PRS. It has been presented at national conferences and workshops hosted by the TRB, AASHTO, and FHWA; and articles about it have been published in professional journals (including *American Society of Civil Engineers* and *Transportation Research Record*), transportation magazines such as *TR News*, *FOCUS*, and *Public Roads*, and industry (American Concrete Pavement Association and National Asphalt Pavement Association) newsletters. As one of the lead agencies in the development of the software, Caltrans IT recently approved CA4PRS as the standard software and started installing it in the engineers' workstations for statewide implementation. Approximately 800 transportation engineers in ten state DOTs have received CA4PRS hands-on user training. On the academic side, approximately ten U.S. universities are currently using CA4PRS for highway research and teaching.

DRI has been taking the lead role both in enhancing the software and its introduction to other state agencies across the nation. With FHWA's support, DRI and the UC Berkeley research team will continue its effort to upgrade the CA4PRS software. More pooled funding is being arranged for the enhancement of the software to add its analytical functionality for roadway widening and bridge replacement projects. A self-paced online training course is also being developed through the pooled fund to cover more end users for basic outreach.

Quieter Pavement Research Program

Traffic noise has become a growing concern to the traveling public, transportation agencies, and industry officials. The public is expecting highway agencies and industry to build "quieter pavement" that helps to abate traffic noise levels. Quieter pavements offer new options for minimizing the impacts of traffic noise levels on the neighborhoods adjacent to highways. In response to this issue, Caltrans developed the Quieter Pavement Research (QPR) Program in October 2006.

QPR is a systematic research program intended to examine the impact of "quieter pavements" on traffic noise levels and establish which pavement characteristics have the greatest impact on tire/pavement noise. Several studies have been initiated under this program to evaluate acoustic properties and performance characteristics of flexible pavements, rigid pavements, and bridge decks used by the State. The QPR studies also focus on identifying surface treatments, materials, and construction methods that will result in a quieter pavement that is also safe, durable, and cost-effective. The information gathered will be used to develop quieter pavement design features and specifications for noise abatement throughout the State.

Because of the amount of work involved, the QPR Program is divided into three areas: Flexible Pavement QPR, Rigid Pavement QPR (including Bridge Decks), and Acoustic Correlation studies. The purpose of the Flexible Pavement QPR is to evaluate the performance of conventional and rubberized asphalt concrete surface course treatments to establish their performance characteristics and optimal design. Similarly, the purpose of the Rigid Pavement QPR is to evaluate the performance of rigid pavement and bridge deck construction methods including texturing, tining, joint widths, and grooving/grinding specifications to establish their noise characteristics and develop an optimal design. The acoustic correlation project is intended to evaluate at-source and laboratory sound testing methods for measuring tire/pavement noise interaction and correlate these methods with the FHWA wayside noise measurement method. This research will also quantify the benefits of quieter pavements for those who live near the highway and establish how long these benefits can be sustained.

Since early 2007, the research team has measured the noise performance of different types of flexible pavements on the testing sections located around the State in different climate regions. The research team will continue to monitor the field noise performance of flexible pavements to evaluate their long-term noise benefits. The Rigid Pavement QPR was begun in July 2008. Similar to the Flexible Pavement QPR, the research team will evaluate the short- and long-term field noise performance of concrete pavements and bridge decks having different types of surface treatments.

Caltrans has also made efforts to collaborate with other agencies, U.S. industry, and other countries on this research. The objective is to review a broad range of options as well as to provide the broadest possible database. In this effort, Caltrans signed an Administrative Agreement with the Danish Ministry of Transportation in July 2007 for

developing a collaborative research program on road infrastructure technologies and quieter pavements. As an initiative of this collaboration, the Danish Road Institute worked with the QPR task group in Caltrans and UCPRC, and provided a scanning summary report in June 2008 on the European policies and specifications for the use of noise reducing pavements.

One of the products of the international collaboration is that a Danish researcher, Mr. Hans Bendtsen, is visiting UCPRC from September 2008 to August 2009 to team up the QPR task group. He is an internationally renowned expert in the area of tire/pavement noise characterization and mitigation. The QPR task group in Caltrans and UCPRC will continue its effort to carry out the planned research program, including: 1) laboratory studies for the acoustic properties and noise benefits of pavement mixtures; 2) field studies for monitoring short and long-term noise performance of pavements; and 3) development of policy documents on the use of quieter pavements.

Warm Mix Asphalt Pavements

Warm Mix Asphalt (WMA) is a set of technologies that reduces the temperature needed to heat hot mix asphalt during the compaction process. It offers the potential to reduce energy use, reduce air emissions, reduce cost, and improve the quality of construction. However, there are several questions that have been identified in California and nationally regarding risks of increased rutting and moisture damage when WMA is used. Caltrans is funding laboratory testing and Heavy Vehicle Simulator (HVS) testing to address these questions for conventional hot mix asphalt and for hot mix asphalt with rubberized binders, which are used extensively in California. The National Asphalt Pavement Association and the Asphalt Pavement Association in California are strong supporters of this effort. These questions must be answered before there is widespread implementation of the new WMA technologies.

HVS test sections with conventional hot mix asphalt were built in Watsonville, California in August 2007 in cooperation with the Granite Rock Company and three WMA technology providers. Results of HVS testing have been completed and indicate that there is no increased risk of rutting in WMA sections compared to the conventional Hot Mix Asphalt (HMA) pavement. HVS testing for moisture sensitivity is currently underway. Plans for repeating this testing using HMA with rubberized asphalt binders are under development.

Vehicle Infrastructure Integration

Safe and Efficient Travel through Innovation and Partnerships for the 21st Century (Safe Trip-21) - The United States Department of Transportation (USDOT) Safe Trip-21 Initiative is part of the national Vehicle-Infrastructure Integration (VII) Program. The objective of the Safe Trip-21 Initiative is to establish test sites that expand and accelerate the VII Program, and build upon ITS research into the application of

electronic information, navigation, and communications technologies. As such, this research can be used to advance national transportation goals for:

- Reducing motor vehicle crashes.
- Alleviating traffic congestion.
- Enhancing transit use and ride sharing.
- Promoting motor freight efficiency and safety.
- Enabling convenient electronic payment options.
- Moderating environmental impacts.
- Reducing unnecessary motor fuel consumption in both urban and rural settings.

Safe Trip-21 seeks to explore and validate the benefits that can be derived by providing travelers, transit workers, and commercial motor vehicle operators with real-time ITS information, navigation, and other services in an integrated, operational, and easy-to-use format.

Connected Traveler Field Operational Test – The first Connected Traveler Field Operational Test was announced as "USDOT Partners with Caltrans to Move California Drivers One Step Closer to Instant Traveler Information and Safety Technologies: Bay Area Selected for One of the World's Largest Intelligent Transportation System Tests." It is a $12.4 million effort, including a $2.9 million grant for USDOT. It is a public-private partnership led by Caltrans, and includes Metropolitan Transportation Commission (MTC), Nokia, NAVTEQ, Nissan, and UC Berkeley (CCIT and PATH). It will unveil a combination of current- and near-term technologies that enable the delivery of safety and mobility information to travelers via consumer mobile devices, such as cell phones; personal navigation devices; and personal digital assistants. In this age of convergence between communications and sensing on consumer mobile devices, the Connected Traveler Project will make extensive use of various technologies from which travelers can benefit. It consists of two tracks, the Mobile Millennium track, and the Group-Enabled Mobility and Safety track, which are described in detail below.

Mobile Millennium Track - the Mobile Millennium track leverages the success of the Mobile Century Experiment (February 2008), which culminated in a successful 100-car, 10-mile loop demonstration on I-880, near Union City, CA. Led by Caltrans and Nokia, and implemented by CCIT and the Nokia Research Center, the experiment demonstrated that accurate and timely traffic data could be collected from probe vehicles using Global Positioning System (GPS)-equipped mobile phones. The Mobile Millennium track expands the scale of Mobile Century to deploy up to 10,000 GPS-equipped phones running a traffic advisory application in the San Francisco Bay Area Region over a period of six months. The end-users will be regular commuters, who will be provided attractive incentives to acquire a Nokia GPS phone and a data subscription plan from a cellular network operator in order to become participants. The team will collect real-time data from the phones, fuse it with other traffic data sources available from NAVTEQ and 511, and then process it into traveler information for distribution back to commuters.

Group-Enabled Mobility and Safety (GEMS) – The GEMS track brings a multi-device and multi-communications link mobility and safety applications focus to SafeTrip-21. The safety component will concentrate on raising the situational awareness of the traveler within his/her nearby environment, using wireless and sensing technologies, to create new safety features for travel. The mobility applications will involve larger scale monitoring using handheld devices to integrate the traveler in his/her regional travel environment. Examples of this include:

- Finding the fastest travel routes.
- Viewing estimated trip times.
- Understanding the extent of traffic congestion.

GEMS includes the design of consumer electronics-based, multi-band On-Board Equipment, enabling both WiFi and Dedicated Short Range Communication (DSRC) system connectivity through an in-vehicle "Gateway." DSRC is a dedicated radio communication band exclusively for transportation use by the U.S. Government. The design has both a GPS capability and a web-based server integrated into the Gateway. The Gateway can be connected to any consumer mobile device via Bluetooth or a Universal Serial Bus port, enabling the device to run GEMS applications through a simple web browser interface.

PATH has worked with TechnoCom Wireless to enable its Roadside Equipment (RSE) product to operate as both a WiFi and DSRC access point. GEMS will leverage this development and procure enough RSEs to expand the size of the VII California Test Bed. These RSEs are identical to the ones being deployed for the 2008 ITS World Congress, hence the RSEs installed in New York City can immediately "talk to" and "listen to" GEMS-connected mobile devices without any modifications. Demonstration of the traveler services enabled by the GEMS track will be a highlight.

Responder System

"A Picture is Worth a Thousand Words." Especially when responding to incidents on a roadway where time is of the essence, Caltrans first responders must collect information, assess the situation, access and manage resources at-scene, and clear the roadway expeditiously. "There is a rock in the road. How big is it?" How do you convey sufficient and accurate information to someone who isn't there but who needs additional information in order to send the right equipment to clear the rock? Answers don't necessarily convey a complete "picture." Additional questions must be answered: Are there other rocks in the road? Is the rock blocking any lanes? What equipment should be sent to clear the rock? First responders from other emergency response agencies such as Emergency Medical Services (EMS) and the California Highway Patrol (CHP) share similar responsibilities. While their specific needs may differ, a system that allows responders to quickly collect and transmit at-scene information would be of great benefit to all.

The Responder System is a communication tool designed for first responders to collect, track, and share incident information quickly and easily with Transportation Management Center (TMC) and secondary incident responders. The system includes a rugged tablet personal computer, GPS, a cellular/satellite modem, and a digital camera. The Responder System allows first responders, particularly those in remote rural areas, to immediately transmit digital photographs from an incident scene complete with highlights, notations, dimensions, and comments. Management can make decisions within minutes and dispatch appropriate resources, resulting in faster incident clearance. This system is especially valuable in: 1) major incidents such as landslides, floods, and earthquakes where the damage could be extensive; 2) remote rural areas where communication is often limited to voice and coverage is sparse; and 3) if the first responder is new or inexperienced in responding to certain situations.

The Responder System was initiated as a component of the Redding Incident Management Enhancement Program. Members include Caltrans District 2-Redding, the CHP, the California Department of Forestry and Fire Protection (CAL FIRE), Northern California Emergency Medical Services, Inc. (Nor-Cal EMS), Shasta Area Safety Communications Agency, and DRI. The goal is to leverage the institutional relationships and technology deployments among these emergency service providers to improve public safety in the region. The Responder System is consistent with national efforts to provide the capability and means to share real-time data and facilitate electronic reporting of incidents among state and local governments. In remote rural areas, such electronic reporting of incidents has generally been impractical.

The main task in the current phase of the project is to test the system in multiple locations and crews in real use situations. The Caltrans Maintenance Division and TMC staff from District 1-Eureka, District 2-Redding, District 3-Marysville, District 4-San Francisco Bay Area, District 6-Fresno, District 7-Los Angeles and District 10-Stockton have tested and evaluated the system since June 2006. Pilot users have all responded with very positive feedback about the system and have found relatively few flaws. Further testing by staff in District 9-Bishop, and District 8-San Bernardino will be scheduled for the next six to nine months.

The Responder System has been presented at various national conferences including the Transportation Research Board Annual Meeting, the ITS America Annual Meeting, the National Rural ITS Meeting, and the Association of Public-Safety Communications Officials International Conference and Exposition. The Responder System was named a finalist in the 2007 “Best New Service, Product, or Application” Category of ITS America’s Best of ITS Awards. The Responder System has also been presented at a Strategic Highway Safety Program subcommittee whose members included the CHP, Nor-Cal EMS, CAL FIRE, and various hospitals.

Cooperative Intersection Collision Avoidance System

The sedan pulls up to a red light and the driver waits for a green light in order to make a left turn. Because there is no arrow, the maneuver will be solely up to the driver. This is among the most dangerous situations on the road: roughly 25 percent of all crashes happen at intersections and another 20 percent are intersection-related.

The statistics argue strongly for some kind of system beyond traditional signal lights and arrows that will support the driver's decision when to execute the maneuver. This is the basis for the Cooperative Intersection Collision Avoidance System (CICAS) project launched in 2006 by FHWA and Caltrans. Caltrans received a grant of $3.65 million from FHWA to develop the CICAS project.

Researchers at PATH have been working to make situations such as these safer by developing intelligent warning and detection systems that could aid drivers in these circumstances. The undertaking has brought together engineers, psychologists, epidemiologists, computer scientists, modelers, systems designers, and communications experts, among others, to provide the technical underpinning for future intersection safety improvements.

The CICAS goal is to achieve the deployment of cooperative intersection collision avoidance systems that can save lives and prevent injuries, thus helping Caltrans achieve its safety goal.

The CICAS project began in late 2006 and is a five-year program to develop a left turn-assist roadway signs at intersections, as well as an in-vehicle sign that will tell drivers when it is unsafe to make a left turn across oncoming traffic. The in-vehicle sign will require a vehicle-to-infrastructure communication capability. Using the DSRC system will fulfill this communication capability.

The CICAS project has brought together a variety of stakeholders working toward a common goal under Caltrans leadership. Caltrans has proven to be effective in garnering support from a variety of organizations including: equipment manufacturers, vehicle manufacturers, city and county governments, metropolitan planning organizations, and various other research entities.

An extensive data collection effort is underway. The collected data pertains to the driving pattern of drivers while negotiating the left turns. This data will help the designers to answer the ultimate question for CICAS project – at what time does the driver need to be notified that negotiating a left turn is unsafe?

Sensys Wireless Traffic Detector

Caltrans has historically employed traffic detectors embedded in the roadway to provide speed, volume, and occupancy data that are not only used internally to plan and design new transportation facilities, but that also give an overall indication of system

performance. The majority of this data currently comes from a vast network of inductive loop detectors embedded in the roadway. The data collection and communication systems for these inductive loop detectors are based on antiquated 1970s-era technology. The reporting data accuracy and reliability are poor. To solve this problem, Caltrans sought a new type of traffic sensor that uses modern microprocessors and robust Transmission Control Protocol/Internet Protocol (TCP/IP) communications. The end result is data that is much more reliable and consistent than what has been reported from most of the existing Caltrans inductive loop stations.

In 2003, DRI awarded $25,000 in new and innovative topic funding to Professor Pravin Varaiya of UC Berkeley to develop a prototype traffic detector for use by Caltrans. With assistance from the CCIT, this project eventually led to the creation of a start-up company, Sensys, to bring this product to market. Sensys developed the product and is now implementing this technology as a fully shipping and supported traffic detector.

The Sensys detector uses a small, low power magnetometer for vehicle detection, instead of the large 2m square inductive loops traditionally used by Caltrans. Although the point magnetometers used by Sensys aren't always as accurate as well-calibrated inductive loop detectors, the data is directly compatible within Caltrans legacy software applications, and the installed cost is much lower.

As deployed, the Sensys detector is a very small, battery powered magnetometer that is installed into the pavement, typically in a speed-trap configuration; e.g., two units per lane to enable it to directly measure speed. Each embedded detector unit communicates wirelessly to the roadside, with a projected battery life of more than five years. A roadside Access Point (AP) collects the traffic data wirelessly. If there is utility electric power readily available, the AP feeds the data directly into the web via wireless Internet modem. If utility power isn’t available, the AP units can be battery powered, sending the data further on down the road until it reaches existing hardwired infrastructure, where it can then be communicated to the Internet.

Each new loop detection station has a total installed cost of $100,000, due to the significant construction costs associated with hardwire trenching along the roadway. Sensys is deployed with no trenching at all, resulting in a considerable reduction in installation costs. A new Sensys station can be installed for approximately a fifth of the cost of a new inductive loop station, and be operational in much less time. In addition, since it uses modern communication technology to transport the data, it is far more reliable than an inductive loop station.

Sensys is used in freeway and arterial count stations, ramp metering, traffic signal control, red-light enforcement, light-rail detection, and parking information systems. Sensys has been deployed around the world in more than 30 U.S. states and 20 countries. Caltrans has deployed the system in several of its districts, including Districts 3-Marysville, 4-San Francisco Bay Area, and 7-Los Angeles.

Integrated Corridor Management

In an Integrated Corridor Management (ICM) corridor, because of proactive, multimodal management of infrastructure assets by institutional partners, travelers can receive information that encompasses the entire transportation network. They could dynamically shift to alternative transportation options—even during a trip—in response to changing traffic conditions.

Caltrans was able to act as a critical partner in the development, deployment, and evaluation of ICM strategies designed to help manage congestion in some of our nation's busiest urban corridors as part of its five-year ICM Initiative. USDOT has selected a total of eight pioneer sites throughout the nation. Of the eight pioneer sites, two of the sites are located in California, in San Diego and Oakland. Caltrans has conducted additional work in these corridors to enhance its submission, such as the extensive study to identify the bottleneck locations on I-880 in the San Francisco Bay Area.

The grant from FHWA in the first phase is $390,000 for two pilot locations. FHWA has picked three out of the eight locations for the second phase in early 2008. San Diego I-15 is one of the three selected corridors. Even though Oakland I-880 did not get chosen for the second phase, it could be considered as a demonstration project for the third phase. Caltrans is hoping that both of these sites will make the cut for the final phase. FHWA will pick up to four sites in the final phase with a potential of over $30 million for those sites.

On December 5 and 6, 2007, Caltrans hosted a workshop on Multimodal Integrated Corridor Management (MICM) at the Caltrans District 7 office in Los Angeles. Caltrans assembled a full spectrum of MICM stakeholders and practitioners for the purpose of brainstorming opportunities, barriers, and ways to overcome barriers to implementing MICM in California.

The workshop attracted 53 attendees from public, private, and academic entities. Some organizations represented include: San Diego Association of Governments; Southern California Association of Governments; Los Angeles County Department of Public Works; City of Los Angeles DOT; MTC; CCIT; California PATH; Dowling and Associates; Kimley-Horn and Associates; Cambridge Systematics; AC Transit; Caltrans Districts 3, 4, 5, 7, 8, and 12; and from Caltrans Headquarters, the Divisions of Planning, Mass Transit, Traffic Operations, and Research and Innovation.

MICM consists of the operational coordination of multiple transportation networks and cross-network connections comprising a corridor, and the coordination among institutions responsible for corridor mobility. All jurisdiction and transportation modes are included.

Travel Times on Changeable Message Signs

A driver is traveling from Sacramento to Oakland on westbound Interstate I-80 for a meeting. When the driver approaches Fairfield, he reads the message displayed on the Changeable Message Sign (CMS) indicating that the travel time to Oakland is 90 minutes. The display also shows that the travel time to Walnut Creek through I-680 is 24 minutes. The driver is a frequent traveler from Sacramento to Oakland and knows that the usual travel time is 30 minutes to Oakland on I-80 and 24 minutes to Walnut Creek on I-680. The driver realizes that there is severe delay on I-80 and he may not make it to his meeting on time. Therefore, based on the information displayed on the CMS, he decides to take Interstate 680 to Walnut Creek and then take State Route 24 to Oakland, which takes him about 50 minutes to get there. The choice by the driver not only enables him to reach his meeting on time, saving 40 minutes, but also balances the freeway capacity by letting travelers use the freeway where capacity exists. Thus, travel times on CMS play an important role in optimum system operation.

The provision of useful real-time information via CMS will in turn reduce system-wide travel time, and improve travel time reliability, which reduces driver uncertainty and anxiety, and fosters a safer travel environment.

Caltrans already has 100 CMSs statewide that are active with travel times; many more are planned to display travel times in the near future.

Currently, Caltrans is conducting studies that evaluate the effectiveness of the travel time messages that are displayed on the CMS. One such effort is looking at the effectiveness of providing transit times, as well as travel times on the CMS such that the commuters can make an informed decision about their travel. This study will provide an insight on how commuters behave once they are given a choice of travel time.

ShakeCast

Following a major earthquake, one of Caltrans most critical tasks is to assess the condition of all potentially impacted bridges and roadway corridors in the State Highway System. Timely response is important to ensure public safety, guide emergency vehicle traffic, and re-establish critical lifeline routes.

In the past, bridge inspection teams had difficulty setting priorities within the first hours following an earthquake because they lacked precise information about where the worst shaking and, most likely, the greatest damage, had taken place. For example, in the 1994 Northridge earthquake, it took several hours to identify damaged areas, which delayed mobilization of bridge inspection teams. In the absence of such data, they were forced to locate the earthquake's epicenter, find the closest fault, and develop a list of bridges within a specified buffer zone surrounding that fault or the epicenter. Often times, the television newscasts would provide the best indicator of damage areas. With this information, inspection teams were then dispersed widely within that region to perform initial reconnaissance. That can take precious time.

A three-year contract with the U.S. Geological Survey was completed in June 2008, which produced a Caltrans-specific version of the software system, *ShakeCast v.2*. ShakeCast is a web-based application that, within ten minutes of an event, automatically retrieves measured earthquake shaking data, analyzes this against individual bridge performance characteristics, and generates inspection prioritization emails and other web-based products for responders. The version 2 software features Intranet-based account management, system administration, and map-based visualization tools, such as exports to Google Earth and ArcMap, as well as customized email and pager messages specific to bridge inspection prioritization activities.

The software was test-deployed on two redundant servers at the Caltrans Transportation Laboratory in Sacramento, California, to support a focus group of 150 earthquake responders. For this version, ShakeCast automatically determines the shaking value at the locations of over 12,700 bridges and facilities for events greater than magnitude 4.0, compares these to pre-established thresholds for notification of damage states for each facility, and then automatically distributes email messages to specified responders within about ten minutes of the event. The email messages contain general information about the event, a summary of impacts to bridges, and, notably, a table of bridges sorted by inspection prioritization.

Pothole Patching Equipment to Reduce Worker Exposure to Traffic

Repair of damaged pavement such as spalling concrete or potholes is an ongoing activity and typically performed with traffic in adjacent lanes. This exposure to traffic increases the potential for accidents and injuries involving workers. Reduced exposure can be achieved by changing procedures or utilizing automated equipment. After an extensive search of available technologies, a unique pothole patching truck was discovered that uses normal pavement materials (hot or cold asphalt concrete) and a compacting roller. This truck performs the entire operation with the operator in the cab; no workers are required on foot. Once acquired, the truck will be tested by Caltrans Division of Maintenance staff to see if it performs as well as expected.

Real-Time GPS Signals for Winter Maintenance Vehicles

Real-time GPS positioning information is being evaluated to help keep Interstate routes open during heavy winter snow events. Snowplow truck drivers are hampered by long periods of low visibility snow conditions. Providing accurate location information to the drivers during heavy snow events provides a level of confidence that is otherwise not available. For example, a real-time GPS system could indicate how far the plow blade is from a guardrail or in what lane the plow truck is driving. It would also help to locate turnouts or other landmarks that may be difficult to observe and helpful for workers new to the area.

Event-Driven Video Monitoring for Driver Training: Pilot Project

The Division of Maintenance, the Division of Equipment, and DRI are evaluating the use of an in-vehicle, event-driven, video monitoring system to improve employee driver behavior. The system records audio, video, speed, and acceleration events. An event is recorded by a trigger, such as speeding over 75 mph. These events are later transmitted wirelessly to the vendor. The vendor reviews the events and provides a score related to the severity of the event. The employee supervisor reviews the scores and provides coaching to staff to reduce identified problems. By coaching employees that drive too fast or that brake too hard, Caltrans can change the way employees are driving to reduce accidents, injuries, lawsuits, and wear and tear on vehicles.

Automated Roadway Debris Vacuum System

Shortly before 1999, Caltrans Division of Maintenance supervisors wanted equipment that reduces worker exposure to traffic and improves efficiency of maintenance operation tasks. Caltrans maintenance operations include activities such as paving, traffic safety, vegetation control and landscaping, snow removal, and crack sealing. The Division of Maintenance and DRI introduced the idea of a vacuum system to clean up debris. This idea was researched by the partnership of DRI and UC Davis Advanced Highway Maintenance and Construction Technology (AHMCT) to design and construct a prototype.

To improve roadside worker safety, DRI and AHMCT pioneered the development of the Automated Roadway Debris Vacuum (ARDVAC) System. The ARDVAC is a self-contained vacuum system that allows for easy removal of debris from roadway edges and collection of litter that tends to blow up against fence lines, vegetation, guardrails, and other objects. Using a joystick control from within a cab, an operator can quickly vacuum behind guardrails, down into depressions, and under bushes. The ARDVAC increases safety by reducing worker exposure to traffic.

After the successful demonstration of the design and development of the ARDVAC nozzle prototype, a commercial company licensed the ARDVAC nozzle design. The commercial vendor, VacAll Industries, fabricated two preproduction machines and delivered the units to Sacramento in January 2008 for inspection by Caltrans. After completion of the modifications necessary to pass the inspection, the two ARDVAC units were delivered to Caltrans Districts 4 and 7, where VacAll Industries provided training to Caltrans Maintenance operators and mechanics in April 2008. AHMCT and DRI are assisting with the field-testing and evaluation of the ARDVAC machines.

Smart Parking

This research project specifically looks at the relationship of technology to land use. The project uses advanced technologies (vehicle detection and changeable message signs) to provide real-time transit parking information. It directs drivers to available

parking spaces at a transit station, thereby encouraging transit ridership, reducing both driver frustration and local traffic congestion. Recently awarded grants from FHWA, this project will allow for more sophisticated parking pricing research and evaluation at five San Diego "Coaster" commuter train stations in San Diego County.

The application of Smart Parking technology to trucks examines the potential for identifying available parking (i.e., matching supply and demand) and providing this and other truck traveler information to truckers. The project will evaluate safety improvements targeted to reduce crashes due to driver fatigue and the number of trucks parking on shoulders and arterials. Project benefits include increased economic productivity, improved air quality (by limiting unnecessary queuing and idling at ports and truck parking facilities), and homeland security benefits to the CHP during emergencies (e.g., security inspections could be conducted at monitored parking locations).

Measuring Bicycle/Pedestrian Activity and Relationship to Land Use

This research project evaluates existing bicycle and pedestrian data sources and collection methods. The project is conducting comprehensive counts and surveys of bicyclists and pedestrians using San Diego County as a model community. Bicycle and pedestrian activity levels relate to facility quality, land use, and demographics. Data collection methods for quantifying usage and demand will enhance research on benefits and exposure, and evaluate how the transit-linkage can be improved. Measuring bicycle and pedestrian activity is a key element to achieving the goals of the California Blueprint for Bicycling and Walking.

Clean Hydrogen for Transportation Applications

This project is comprised of hydrogen-related research teams from the private sector, federal agencies, and academia. The project will carry out hydrogen-related research and studies, which support the Governor's Hydrogen Highway Network mandate. This project will also help to determine the social and financial viability of hydrogen as an alternative transportation fuel. Research-based recommendations include planning, market analysis, economic viability, and environmental conformity for stationary and mobile fueling sites. The first product was a presentation of the Governor's Hydrogen Highway scenarios, including fuel dispensing options, associated costs, regulatory/safety concerns, and citing options including the new Caltrans Shop 7 in Los Angeles. In addition, Caltrans participated in the Governor's Hydrogen Highway Blueprint/Rollout Strategy Topic Team Activities headed up by California Air Resources Board (CARB) and the California Environmental Protection Agency (CalEPA).

Alternative Fuels and Petroleum Replacement

DRI, in partnership with the Division of Equipment has initiated the development of a pilot project to implement a system to monitor and track the use of Ethanol 85 (E85) in the Caltrans fleet. Caltrans currently operates more than 650 flexible fuel E85 vehicles. The system will collect data on fuel usage (percent of E85 being burned) along with information on the locations where the vehicle is refueled.

This GPS based system will allow supervisors and managers to monitor fuel usage in ensuring that the vehicles are operated on E85 to the extent feasible and available. This research project will also develop a deployment plan to implement the system throughout the flexible fuel vehicle fleet. Full-scale implementation of the system into the fleet could begin in early 2010. It is anticipated that within that timeframe, there will be sufficient refueling stations throughout California so that the fleet may maximize E85 usage.

Alternative Fuel Fleet Monitoring System

Caltrans has initiated a telemetry research project to measure fuel consumption rates of various vehicle types. Quantifying fuel used while engaged in a job versus traveling to the job site and analyzing the idle and power cycles of stationary vehicles could result in the efficient use of idle shut-down systems. Also, opportunities for gaining tax credits for fuel consumed during off-road activities by licensed on-road vehicles may be pursued.

Working with UC Davis and with private industry equipment manufacturers, Caltrans is installing hardware in a pilot group of vehicles that includes a microprocessor-based data collection device. The product provides real time location information via GPS, as well as engine operating parameters, including real-time fuel consumption through an interface with the vehicle manufacturer's data bus. Activation and deactivation of auxiliary work systems are monitored through custom hardware interfaces. All information is sent to a database via integrated wireless cellular communications, making it available for analysis by the researchers, practitioners, and fleet operators.

Queue Detection and Count Information Systems

The Queue Detection System and Count Information System are web-based applications intended to help mitigate traffic incidents that occur on an exit-ramp in Redding, California. When a traffic queue is detected via inductor loops, a CMS located downstream is activated to let motorists know that slow or stopped traffic conditions are ahead. The system provides personnel in the TMC more control during times of traffic incidents and provides logs of past traffic data for reference. This system makes roads more reliable by warning motorists of potential hazards.

Automated Speed Enforcement

Caltrans is currently conducting research on the impact of Automated Speed Enforcement (ASE) deployment on the State Highway System. Jurisdictional differences, public perception, and traffic speeds and volumes are some of the areas that make the State Highway System unique for ASE deployment. Caltrans is required to report all traffic crashes to the federal government and must develop plans to address and reduce higher-than-average traffic crash rates. The use of ASE will enable governments to modify driver behavior that cannot be addressed by changes in alignment and/or operation of the roadway.

Existing research is focused on two areas – technical feasibility and institutional acceptance of ASE deployment. Technical feasibility aims at understanding effectiveness measures, primarily reliability. In the first phase, the project will deliver summaries of legal and constitutional analysis, literature review, expert interviews, and focus groups. Additionally, summaries of stakeholder interviews and meetings, the results of data/report evaluation, and the observational analysis will also be included in the final report. In the second phase, the deliverable will include the methodology for testing ASE units, with associated software tools and documentation. In addition, performance of the candidate ASE systems tested, and criteria for testing will also be included.

Multi-modal Advanced Transportation Management Systems

The California Advanced Transportation Management Systems (ATMS) Research Program at UC Irvine, is continuing research and evaluation of emerging technologies and applications in support of the Caltrans initiative to improve mobility, travel reliability, and productivity. The program partners include FHWA, UC Irvine-Institute of Transportation Studies, California Polytechnic State University at San Luis Obispo, CHP, the Cities of Anaheim and Irvine, and various technology providers.

Leveraging Orange County's transportation network of surface streets and freeways linked to the TMC and to dedicated research facilities, the researchers and practitioners are engaged in joint system management studies. The infrastructure includes a sophisticated computerized laboratory that provides the means to collect and store real-time transportation data for research, as well as for training of traffic management personnel. The capabilities include a traffic detector test site situated on I-405 in Orange County that is comprised of side-mount, in-pavement, and overhead-mount traffic detection technologies and advanced wireless detectors.

California ATMS Testbed Program Detector Test Site- The capabilities of the detector test site situated on I-405 in Orange County that is comprised of side-mount, in-pavement, and overhead-mount traffic detection technologies was enhanced through addition of advanced in-pavement wireless detectors.

Caltrans is interested in making information about highway travel conditions available, and one of the most useful metrics is travel time between various locations. Current methods of travel time estimation involve extrapolation across a given distance based on speeds measured at a single spot on the highway. However, congestion and incidents on other stretches can reduce the accuracy of these estimates.

Using the Detector Test Site, a current research project hopes to generate more accurate travel times using a "re-identification" methodology. Vehicle measurements taken at a downstream detector station are matched with the vehicle's corresponding measurement at an upstream station. The time intervals of the resulting matches will allow for accurate travel time measurement between stations and enable detection of congestion and incidents before the effects of queuing are locally observable at a single detector station. This new method uses existing field hardware programmed with new software capable of higher resolution measurement. This travel time data could be used to improve many traffic management applications, such as automatic incident detection, adaptive freeway ramp metering, and traveler information systems.

Virtual Weigh Station

The public-private partnership between the Caltrans, CHP, and private industry to demonstrate the state of the technology in Virtual Weigh Station development continued at the Cordelia location. Additional technologies continue to be evaluated as candidates for statewide deployment.

Plans are also being developed to implement a Weigh-in-Motion (WIM) test facility near an existing Commercial Vehicle Inspection Station to allow investigation of the relationship of static weights obtained at the Inspection Station with the dynamic weights obtained by the various WIM technologies. Integral to this effort is the development of a broader research program to assist in better understanding of the dynamics of the roadway interaction with the truck suspension in relationship to the data measurements obtained from WIM systems. Identifying an accurate and efficient way to weigh trucks while moving at freeway speeds will provide the CHP, local law enforcement agencies, and Caltrans a more effective tool to enforce the laws and to manage the impacts of overweight trucks on California's highways.

Commercial Vehicle Operation Safety

DRI, in collaboration with the Federal Motor Carrier Safety Administration (FMCSA) and the California PATH program developed a prototype On-Board Monitoring System (OBMS) used for monitoring safe vehicle operation and discerning the driving behavior of the commercial vehicle operator. The system has the potential to significantly reduce truck-related incidents and to streamline the operation of the fleet resulting in improved safety, better air quality and lower operating costs.

The OMBS provides warnings to drivers when an unsafe action is detected. It enables the commercial carrier fleet managers and safety officers to use the data as a tool to monitor and improve the behavior of their truck drivers. The prototype system monitors more than twenty truck operational parameters and captures data and video from specific events such as hard braking and sudden lane changes.

California University Transportation Centers

The federal Transportation Equity Act for the Twenty-First Century (TEA-21) authorized the establishment of University Transportation Centers (UTC) with the primary purpose of conducting a multidisciplinary program of transportation education that produces transportation professionals for Caltrans and other transportation agencies.

The Federal Research and Innovative Technology Administration provides a 50 percent federal match for each UTC, while Caltrans provides the remaining match under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. In FY 2007/08, Caltrans provided $4.1 million in match funding.

University of California, Berkeley – University of California Transportation Center (UCTC) funds research on surface transportation but will consider proposals on air or maritime transportation topics that have significant surface transportation components. Research is structured to address pressing issues centered on the theme of transportation systems analysis and policy.

San Jose State University - Mineta Transportation Institute (MTI) stresses policy research in distinction to technical research where activities are oriented towards improving aspects of the development and operations of the nation's surface transportation systems, improving transportation decision-making, and ensuring the U.S. continued global competitiveness.

National Center for Metropolitan Transportation Research (METRANS) theme is transportation within large metropolitan areas conducting research in four topical areas: goods movement and international trade, urban mobility, infrastructure, and safety and security, oriented specifically to metropolitan transportation problems.

University of California, Davis - Sustainable Transportation Center (STC) at the Institute of Transportation Studies at UC Davis (ITS-Davis) encompasses many high-priority research awards, particularly those related to Planning and Environment; Policy Analysis, Planning, and Systems Monitoring; and Operations and Mobility.

California State University, San Bernardino - Leonard Transportation Center focus areas include: Delivery, Stewardship, Goods Movement, Mobility, Transportation Finance, and Public Transit; while also addressing the Center's theme: Decision Making and Management of Transportation Systems.

The following are a few highlights from FY 2007/08:

- UCTC added 108 papers to their website and converted most of the older papers to electronic format, allowing almost all of UCTC's 721 publications to be obtained over the Internet.
- Supported the annual Lake Arrowhead retreat, organized a student-run conference in Los Angeles, and hosted the UTC/PATH Transportation Sustainability Conference.
- At MTI, over 60 California State University accredited Master of Science in Transportation Management degrees have been granted since 1999.
- MTI's Garrett Morgan Symposium on Sustainable Transportation culminates in a national videoconference symposium featuring presentations by participating middle-school classes and is designed to increase students' awareness of transportation issues, interest them in careers in transportation.
- METRANS monthly Town Hall meetings have received wide recognition in the goods movement industry.
- The first National Urban Freight Conference afforded researchers and practitioners a unique opportunity to consider the "urban side" of freight across many disciplines.
- UC Davis, STC first year accomplishments include: seven dissertation fellowships; five graduate student program fellowships; five graduate student travel awards; five faculty research grants; three undergraduate student fellowships; three conference co-sponsorships; three features in quarterly electronic newsletters; two distinguished speakers; one visiting practitioner; one outstanding student of the year award; and one graduate seminar in road ecology.
- The Leonard Transportation Center held major conferences: the Second Annual Leonard Transportation Center Forum: For Whom the Road Should Toll – The Future of Toll Roads and Road Pricing in California and Clearing the Air: Issues and Strategies for Future Progress Conference.

Appendix

Strategic Research Priorities: The RDSC approved nine Strategic Research Questions as Strategic Research Priorities for FY 2008/09 funding:

- M1 - DATA - How can we improve/enhance data collection and interpretation across modes?
- M2 - INTEGRATED CORRIDOR MANAGEMENT - How can we optimize movement through a corridor?
- M5 - TRAVEL DEMAND MANAGEMENT (REAL-TIME) - What are the most effective real-time strategies to influence travel demand?
- M6 - TRAVEL DEMAND MANAGEMENT (SYSTEM ELEMENTS) - What transportation system elements and land use options are most effective in reducing travel demand by enhancing choices?
- M8 - GOODS MOVEMENT - How can we improve goods movement throughout the State to generate jobs, increase mobility and relieve traffic congestion, improve air quality and protect public health, enhance public and port safety and improve California's quality of life?
- SF1 - DESIGN/CONSTRUCTION - What design features and construction standards can be utilized to improve highway safety?
- SF4 - PROACTIVE SAFETY - What can Caltrans do to mitigate collisions?
- ST6 - CLIMATE CHANGE - How can Strategic Growth Planning be advanced through addressing climate change adaptations and mitigations?
- ST9 - TRANSPORTATION INFRASTRUCTURE (e.g., Pavement, Structures, Maintenance Stations, Office Buildings, and others not listed) - How can we optimize the performance of our transportation infrastructure?

Best Practices: The RDSC approved 15 Strategic Research Questions for Preliminary Investigations to identify Best Practices:

- M3 - INCIDENT MANAGEMENT - How can we manage incidents to reduce effects on traffic and improve system reliability?
- M4 - ACTIVE TRAFFIC MANAGEMENT - What are the most effective ways to manage vehicles on the roadway?
- M9 - SUSTAINABLE TRANSPORTATION AND COMMUNITIES - How can we integrate the transportation system into the community so society benefits?
- SF3 - WORKER SAFETY - What tools, technologies, and policies should be researched and implemented to improve administrative and engineering safety controls in the work environment?
- SF5 - REACTIVE SAFETY - What can Caltrans do once collisions occur?
- SF6 - DRIVER BEHAVIOR - How can we influence/educate drivers to operate their vehicles more safely?

- ST2 - LIFECYCLE BUDGETING FOR INFRASTRUCTURE - How can we better measure the impact of asset decisions on Caltrans finances?
- ST3 - LIFECYCLE COSTS - How can we incorporate lifecycle cost analysis into decision-making?
- ST5 - NATURAL AND PHYSICAL ENVIRONMENT - What can we do to reduce impacts to the natural and physical environment?
- ST7 - ASSET MANAGEMENT - How can we improve corporate inventory of assets and information (from structures to salamanders)?
- SV3 - INNOVATION - How can Caltrans foster innovation and risk-taking?
- SV4 - EMPLOYEE RETENTION - What are the most effective strategies to attract, select, and retain employees?
- SV6 - TOOLS - What tools are needed to properly perform each job in Caltrans?
- D4 - PURPOSE AND NEED - How can we establish and meet the purpose and need of the project throughout the project development process?
- D6 - ENGINEERING ESTIMATES - How can Caltrans improve the accuracy of capital cost estimates?

Low Priority: The RDSC identified 14 Strategic Research Questions as Low Priority for FY 2008/09 funding:

- M7 - SYSTEM DESIGN - How do we design state highway facilities to maximize movement of people and goods?
- SF2 - ORGANIZATIONAL/INSTITUTIONAL - What organizational and institutional changes lead to improved safety?
- D1 - SCHEDULE - How can we set and meet realistically aggressive schedules?
- D2 - PROJECT MANAGEMENT - How can we effectively and efficiently manage delivery throughout the life of projects?
- D3 - PRIORITIZATION AND SELECTION - How can we prioritize projects so the most needed projects are delivered with the available resources?
- D5 - QUALITY - How do we ensure that the quality level of project deliverables match the purpose and need of the project?
- D7 - CAPITAL COST - How can we get the best value from capital dollars?
- D8 - CAPITAL SUPPORT COSTS - How can we use support resources most efficiently?
- SV1 - TRAINING - What competencies are not adequately addressed by existing training and how might these competencies be developed?
- SV2 - COMMUNICATION - What are the most effective ways to improve communication between Caltrans management and employees?
- SV5 - QUALITY SERVICE - What skills are necessary to develop an excellent workforce that provides quality service?

- ST1 - FINANCIAL FLEXIBILITY - How can state funding be used more flexibly to meet performance-based needs?
- ST4 - CULTURAL RESOURCES - How can we better manage our cultural resources?
- ST8 - EXCESS PROPERTY MANAGEMENT - How can we better approach asset management and excess land disposal in a business-like manner?

Notes:
The Department's five adopted Strategic Goals (Caltrans Strategic Plan 2007-2012, 12/17/07):

SA: Safety
M: Mobility
D: Delivery
ST: Stewardship
SV: Service